REMARKS

The following remarks are responsive to the Office Action of November 28, 2005.

Claims 1-12 are pending. Claims 1-4 and 8-9 stand rejected under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 6,678,263 to Hammons Jr. et al. (hereinafter Hammons). Claims 5 and 10 stand rejected under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 6,698,248 to Elgamal et al. (hereinafter Elgamal) and Hammons in view of admitted prior art on pages 5-6 of the specification. Claims 6-7 and 11-12 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form.

Although the Applicants appreciate the indication of allowable subject matter in claims 6-7 and 11-12, Applicants have not amended claims 6-7 and 11-12 to be in independent form. Rather, the Applicants have amended the broader claims 1, 5, 8 and 10 to more clearly distinguish Applicants' claimed method and system. The claim amendments find full support in the as-filed specification and no new matter is added. Applicants respectfully request reconsideration and allowance in view of the instant amendment and remarks below.

Remarks regarding Applicants' system and method

Advantageously, the Applicants' system and method, as claimed, provides a high rate STTC coding by spatially multiplexing several STTC codings. Furthermore, Applicants' system and method provide a good balance between diversity introduction (because of the multiplicity of STTC codings) and spatial multiplexing. Moreover, the Applicants' system and method allows for concatenating the STTC coding multiple structure with an interleaved convolutive binary code, so as to take advantage of the temporal (if any) and remaining spatial diversity which takes place between the several STTC codings.

A space-time encoder according to the invention differs from the prior art in particular because the prior art references taken alone or in combination do not disclose, teach or suggest a multi-layered structure. Reciting claim 1 as an example, the advantages of the present invention are realized through the following unique steps:

(1) outer coding by means of a first code to generate a coded digital stream,

(2) blockwise bit interleaving to generate a coded and interleaved digital stream,

(3) demultiplexing into a given number of elementary interleaved coded digital streams, each elementary interleaved digital stream consisting of a layer of rank m (see page 16, lines 29-30 of the as-filed specification)

(4) inner coding by means of a second code to generate a set of elementary digital stream, coded by spatio-temporal combinations, owing to the subdivision into layers of rank m and to the specific inner coding combined with the aforesaid outer coding (see page 17, lines 29-33 of the as-filed specification), and

(5) transmitting the coded stream through a plurality of transmitting antennas.

Each layer of rank m, in addition to the quality of temporal diversity introduced thanks to the outer coding and to the interleaving, makes it possible to introduce a specific spatial coding (see page 16, lines 29-36).

As disclosed on page 34, lines 4-15 of the as-filed specification:

-temporal diversity and spatial diversity remaining between the layered STTCs is achieved by means of the outer coding introduced by the coding module 10 and the bit interleaving module 11;

-spatial diversity is achieved by means of the processing by layers of rank m of each frame, of the spatio-temporal coding introduced by each inner coding module 13_1 to 13_v and of the transmission by each of the constituent antennas of the aforesaid array of antennas.

Thus, as can be appreciated, the space-time codes according to the Applicants' system and method do not aim at achieving full diversity. Rather, the unique sequence of steps of the invention as set forth for example in claim 1 allows one to achieve a trade-off between diversity and bit-rate.

Moreover, Applicants respectfully point out that, as stated on page 2, lines 1-7 of the as-filed specification, the present system and method applies to frequency selective channels which are subject to intersymbol interference (ISI). To this end, Applicants have amended claims 1, 5, 8 and 10 to more clearly distinguish the claimed system and method.

Remarks regarding Hammons

The Examiner contends that Hammons discloses a full diversity space-time encoder. The encoder is illustrated in Figure 4 of Hammons and is referred to with reference number 218. As shown and described, the encoder includes an outer code 112 that provides signals to a spatial formatter 114, which itself separates signals for coding at inner code 116a, 116b and 116c. However, the Examiner admits that Hammons does not show a blockwise interleaver in Figure 4, but states that it would have been obvious for one of ordinary skill in the art to implement a block channel interleaver (e.g., Figure 1, element 20 of Hammons) after the outer code 112 to randomize burst errors in view of col. 35, lines 10-35.

Applicants point out that Hammons discloses a method for designing space-time codes, which provide full spatial diversity in a multi-antenna system (col. 5, lines 46-49). In contrast to Hammons, the Applicants' specific sequence of steps recited in the claims does not aim at providing full diversity. Rather, the Applicants' system and method relies on a multi-layered structure which allows one to compensate for a lower diversity order of the space-time codes being used.

In further contrast to Applicants' system and method, Hammons only considers flat Rayleigh fading channels (either quasi-static or time-varying) (col. 2, lines 1-2; col. 2, lines 15-17; eqn (1); col. 16, line 41). That is, channels which are not frequency selective, and thus are not prone to intersymbol interference (ISI). Applicants have amended independent claims 1, 5, 8 and 10 to better clarify the foregoing distinction.

Even if assuming that one of ordinary skill in the art might have been tempted to add an interleaver to Figure 4 in Hammons in view of col. 35, l. 19-22, the addition of an interleaver would not have resulted in the recited steps or structure of the Applicants' method and system. Actually, in the present invention, the outer code is defined relative to the interleaver, and is called "outer code" because it is placed before the interleaver. Such an outer code is aimed at adding redundancy before the interleaver. It is the concatenation of the outer code and of the interleaver which allows for generation of an interleaved coded digital stream exhibiting specific temporal diversity (see page 16, line 6-12 and page 32, lines 28-34 of the as-filed specification).

The outer code in Hammons does not fulfill the same function as Applicants' outer code. Furthermore, since there is no interleaver in Hammons, the outer code cannot be

defined relative to such an interleaver, and hence it cannot correspond to the outer code of the present invention.

It is the frequency selectivity of the channels that is considered by the Applicants to have led to the design of the multi-layered structure of the invention. Thus, the mere and direct use of the space-time encoder of Figure 4 of Hammons is inappropriate for use in such a frequency-selective context.

The design method disclosed by Hammons is based on a set of design rules in the binary domain (col. 5, lines 39-43). Thus, referring to Figure 4 of Hammons, the data at the input of the space-time encoder 118 are binary elements that undergo an outer binary coding 112 as well as an inner scalar coding 116, after which the elements are parsed to various transmit antennas. After the inner coding step 116, the encoded symbols are mapped by the modulators 118a, 118b, 118c, onto constellation points from a discrete complex-valued signaling constellation for transmission across the channel (col. 7, lines 55-59).

In contrast to the Applicants' invention, Hammons discloses a method for designing in the binary domain a unique STTC coding. That is, Hammons does not disclose how to achieve a spatial multiplexing of several STTC codings according to the unique process defined by the steps of the claims of the present invention.

In view of the foregoing, one might consider that the space-time encoder of the present invention could be built by spatial multiplexing of several space-time encoders. For example, Figure 3b of the as-filed specification shows a coding system in which each inner coding element 1, m, v, could be implemented in the form of a space-time encoder, for example, as disclosed by Hammons having an outer code 112 and a spatial formatter 114 as shown in Figure 4of Hammons.

In view of the amendments to claims 1, 5, 8 and 10 and the foregoing remarks Applicants submit that claims 1-4 and 8-9, which stand rejected as being obvious over Hammons, are allowable.

Remarks regarding Elgamal

The Examiner contends that Elgamal does not teach the step of equalization of transmission channel at the receiving side, but that it is well known that an equalizer is necessary to compensate for intersymbol interference resulting from channel distortion.

Furthermore, the Examiner contends that it would have been obvious for one of ordinary skill in the art to modify the Elgamal receiver so as to implement the step of equalization in relation to reception of the space-time signals transmitted by Hammons.

Applicants point out that a major advantage of the presently claimed coding method and system is that a sub-optimal joint equalization and decoding process can be carried out in reception. The inner code, which makes it possible to equalize the transmission channel, is strengthened by the introduction of a trellis coded modulation, the trellis of the resulting inner code being reducible to a combination of the TCM code and of the frequency selective transmission channel, the process of equalization and of decoding of the resulting trellis, when the latter is reduced, being thus reduced to a sub-optimal joint equalization and decoding process (see p. 10, lines 4-15).

Since Elgamal does not teach performing an equalization step, it does not a fortiori suggest realization of a joint equalization and decoding process.

Even if, for argument's sake, one of ordinary skill in the art might have been tempted to add an equalization step to the Elgamal decoding method, he would have thus achieved a joint equalization and decoding process as is recited in the pending claims.

As set forth in the present invention (see p. 11, lines 4-10), the joint equalization and decoding operations are executed on trellises which are much reduced in complexity as compared to the prior art. The computational complexity of the receiver is correspondingly reduced, while equalization and decoding performance similar to an optimal equalization and decoding process are retained. See also page 27, lines 12-23 of the as-filed specification.

Elgamal discloses a receiver comprising a space-time demodulator 26 and a space-time decoder 28 (see Elgamal, Figure 1) which follow each other. Since the demodulator 26 and space-time decoder 28 follow each other, they do not provide a joint processing.

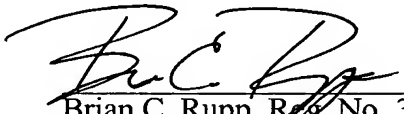
Moreover, in Figure 4 of Elgamal, the SISO decoders 48a to 48n are preceded by deinterleavers 46a to 46n and followed by interleavers 50a to 50n. Even if one might consider adding an equalization step to the decoding process of Elgamal, the presence of the de-interleaver/linterleaver would thus impede achievement of a joint equalization and decoding process.

It is also noteworthy to emphasize that Elgamal (col. 13, line 26 to col. 14, line 35) teaches that the proposed iterative detection algorithms do not apply to a multi-layered

architecture. Since Applicants' coding system and method are of the multi-layered type, hence, one of ordinary skill in the art would not have considered the Elgamal teachings to design a decoding method according to the invention.

Based upon the foregoing amendments and arguments, applicant respectfully requests the examiner to reconsider the application and withdraw the rejections. The application is considered in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,



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CERTIFICATE OF MAILING

I hereby certify that this RESPONSE TO OFFICE ACTION OF NOVEMBER 28, 2005 (along with any documents referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Date: April 28, 2006 I. Mikitiouck
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